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Research Article

Improving Efficiency and Digital Literacy through a Web-Based Ordering System in PEM Akamigas Warehouse

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Abstract

This research aims to design and develop a web-based material ordering information system for the Warehouse Laboratory of PEM Akamigas, which previously relied on manual recording methods that were vulnerable to errors, data duplication, and inefficiency. The study adopts an applied Research and Development (R&D) approach encompassing observation, interviews, document analysis, system design, prototyping using PHP and MySQL, and black box testing to ensure system functionality and reliability. The developed system integrates essential features, including user registration, product catalog browsing, order management, automated invoice generation, real-time stock updates, and comprehensive sales reporting, along with an administrative dashboard that facilitates data monitoring, improves decision-making accuracy, and enhances transparency between users and warehouse administrators. The implementation results demonstrate that the web-based system significantly increases data accuracy, reduces human error, and streamlines the ordering workflow, leading to more efficient operations. Furthermore, this innovation aligns with Industry 4.0 principles by promoting digital transformation in logistics education and strengthening the laboratory's role as a learning facility that mirrors real-world warehouse operations, thereby improving students' digital literacy, technical competence, and readiness for professional practice in the logistics and energy sectors.

Keywords: Digital Literacy, Material Ordering, Operational Efficiency, Warehouse Laboratory, Web-Based Information System

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INTRODUCTION

Warehouse management is a central pillar of modern supply chain operations, directly influencing service levels, cost efficiency, and responsiveness to market dynamics. The importance of effective warehouse operations extends beyond commercial settings and into education, where laboratory-based learning environments allow students to simulate and understand industry practices (Zaman et al., 2025). In educational institutions such as PEM Akamigas, the Warehouse Laboratory is designed to provide students with direct experience in inventory management, order processing, and material tracking, bridging the gap between classroom theory and real-world logistics practice (Tubis & Rohman, 2023; Vicente et al., 2024).

However, the current manual system used for recording orders and stock movements in the laboratory has significant limitations. Orders are often communicated informally through chat applications or written notes, and stock records are updated by hand on printed forms or spreadsheets (Garg, 2025). These practices expose operations to risks of data duplication, record loss, and calculation errors, which can lead to inaccurate stock levels, delayed reporting, and ultimately reduce the educational value for students who need exposure to industry-standard systems (Rana, 2023).

In Indonesia, the logistics education sector faces significant challenges due to the reliance on manual processes in warehouse management. Studies have shown that manual methods lead to inefficiencies, errors, and missed opportunities for real-time data tracking (Tikwayo & Mathaba, 2023). These challenges hinder the effectiveness of training programs in educational institutions like PEM Akamigas. As the demand for digital literacy in logistics increases, it is crucial to introduce digital systems into educational warehouse operations (Aravindaraj & Rajan Chinna, 2022).

Data from previous studies (Ropianto et al., 2020) indicate that Indonesian educational institutions adopting digital warehouse management systems show marked improvements in data accuracy and operational performance (Popović et al., 2021). This research aims to address the gap in integrating such systems in warehouse laboratories at PEM Akamigas.

The emergence of Industry 4.0 has brought forward a paradigm shift in warehouse operations, characterized by the adoption of digital tools, real-time data tracking, and system integration to enable higher levels of automation and accuracy (Perotti et al., 2022; Tiwari, 2023). Warehouse Management Systems (WMS) play a critical role in this transformation by automating order management, inventory updates, and reporting processes, thus minimizing manual interventions and human error (Alamsah et al., 2024). Educational institutions that adopt such systems in laboratory settings not only improve operational efficiency but also prepare students to engage confidently with technologies prevalent in the logistics sector (Kihel, 2022; Liu et al., 2020)

This study aims to transition from a manual, error-prone system to a digital platform capable of securely recording transactions, generating accurate invoices, updating stock levels in real-time, and producing sales and stock reports automatically (Batarlienė & Jarašūnienė, 2024; Sun et al., 2022).

The study also builds upon existing academic discussions about the importance of integrating digital tools in warehouse settings to complement improvements in physical layout and resource allocation (Ariyanto & Widhiyanto, 2023; Bulková et al., 2025). The web-based system developed in this research is intended as both an operational tool and a pedagogical medium, aligning laboratory activities with current industry standards while fostering digital literacy among students (Diwangkoro, 2025).

Ultimately, this research addresses two intertwined challenges: improving the operational efficiency of the Warehouse Laboratory and modernizing logistics education by embedding real-world digital practices into the curriculum (Asrol, 2024; Shivam & Gupta, 2024). The findings of this study are expected to offer valuable insights for similar educational

institutions seeking to integrate warehouse management systems into their practical learning environments (Bélanger et al., 2023; Minashkina & Happonen, 2023).

RESEARCH METHOD

Research Design

This study employed an applied research design integrated with a Research and Development (R&D) approach. The R&D model was chosen to systematically guide the process of identifying problems, designing solutions, developing a prototype, and evaluating its effectiveness (Sitorus et al., 2020). The research followed five main stages: analysis, design, development, implementation, and evaluation.

The study was conducted at the Warehouse Laboratory of Politeknik Energi dan Mineral (PEM) Akamigas, located in Cepu, Indonesia, from January to May 2025. This site was selected because the Warehouse Laboratory functions as a practical learning environment for students in the Oil and Gas Logistics Study Program and currently operates using a manual system for recording, ordering, and stock management (Pinasthika et al., 2016). This setting provided a relevant environment to observe existing workflows, test the system prototype, and evaluate its impact on both operational performance and digital literacy enhancement.

Research Target/Subject

The research subjects consisted of two main groups: warehouse administrators (laboratory staff) and students who used the laboratory facilities for learning activities. These groups were selected through purposive sampling to ensure that only individuals directly involved in warehouse operations and material ordering participated in the study. The administrators provided insights into system requirements, workflow challenges, and data management needs, while the students contributed feedback from the user perspective (Akbar & Fajar, 2024).

Research Procedure

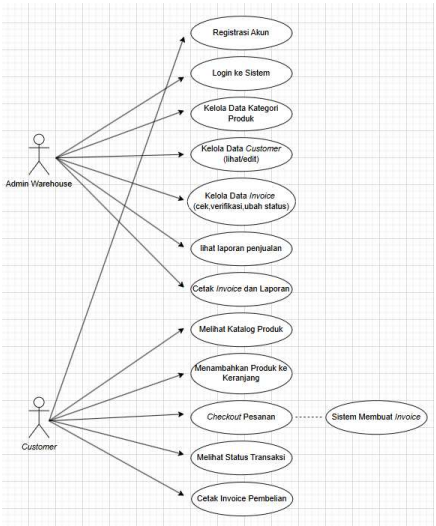

Figure 1 Use Case Diagram of The System

The research procedure followed the stages of the R&D model as adapted for system development projects:

1. **Analysis Stage** – Observation and interviews were conducted to identify warehouse workflows, problems, and user requirements. Document analysis was also carried out using existing stock cards, order records, and manual reports to identify inefficiencies.
2. **Design Stage** – The system was designed using several modeling tools: Use Case Diagram, Activity Diagram, Data Flow Diagram (DFD), and Flowchart. These tools

were used to describe user interactions, process sequences, and data flow within the system.

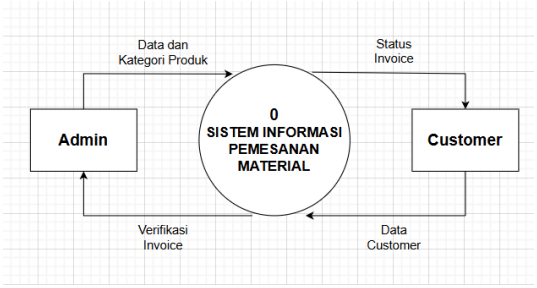

Figure 2 Data Flow Diagram (DFD) Level 0

3. **Development Stage** – The system prototype was developed using PHP as the backend scripting language and MySQL as the database management system. These technologies were chosen for their scalability, open-source nature, and relevance in educational settings.
4. **Implementation Stage** – The developed system was installed and tested in the Warehouse Laboratory to evaluate its functionality and usability.
5. **Evaluation Stage** – The prototype underwent testing using a black box testing approach to verify whether the features functioned correctly according to the design specifications (Rad et al., 2022).

Instruments, and Data Collection Techniques

Data were collected through several techniques:

- Observation was used to analyze the warehouse's existing manual processes.
- Structured Interviews with warehouse administrators and lecturers identified system needs and user preferences.
- Document Analysis examined order records, stock cards, and reports to determine patterns of error and inefficiency.
- The instrument used for data recording included observation sheets, interview guides, and documentation templates.

The collected data were then used to define system requirements and evaluate the prototype's performance during the testing stage.

Data Analysis Technique

The data obtained from the observation and interviews were analyzed qualitatively to identify recurring issues and user needs. Meanwhile, the results of black box testing were analyzed descriptively to determine whether each system function operated as intended. Comparative analysis was also performed between the manual and digital systems to measure improvements in accuracy and processing time. The evaluation results were used to conclude the system's effectiveness in enhancing operational efficiency and supporting digital literacy in logistics education (Tiwari, 2023).

RESULTS AND DISCUSSION

A. System Comparison and Performance Evaluation

Research To evaluate the effectiveness of the developed web-based material ordering information system, a comparison was conducted between the manual system previously used in the Warehouse Laboratory and the newly developed digital system. The assessment focused on two key variables: **accuracy** and **processing time** (Hasanudin, 2018).

The results are summarized in **Table 1**, which shows a significant improvement in both parameters after implementing the digital system.

Table 1 Comparison of Accuracy and Processing Time Between Manual and Digital Systems

System Type	Accuracy (%)	Processing Time (minutes)
Manual System	80	120
Digital System	98	60

The **Figure 3** presents a visual comparison of accuracy, indicating that the digital system achieves a much higher accuracy rate due to automated data validation and integrated stock updating mechanisms.

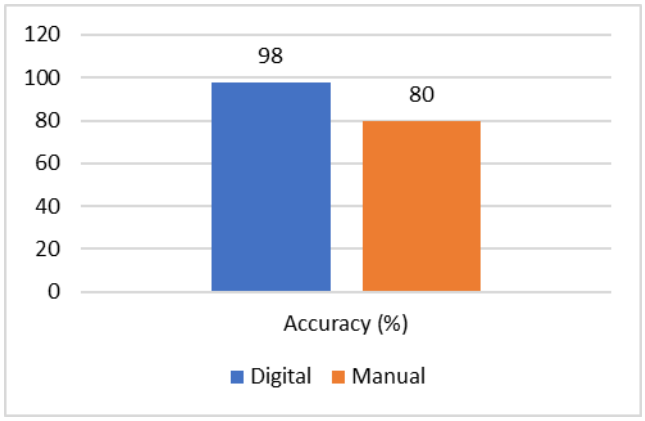

Figure 3 Accuracy Comparison: Digital vs Manual

Similarly, **Figure 4** shows that the digital system significantly reduces order processing time. While the manual process took approximately two hours to record, verify, and report an order, the new system completes the same task in one hour or less.

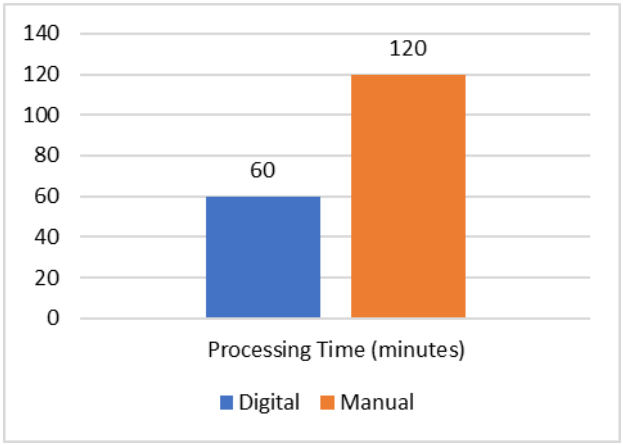

Figure 4 Processing Time: Digital vs Manual

These results demonstrate that digitalization improves both data reliability and operational efficiency. The automated functions—such as real-time stock updates, automatic invoice generation, and database integration—reduce human error and accelerate reporting. This finding aligns with the research of (Ropianto et al., 2020), who found that web-based warehouse systems improve productivity and minimize duplication errors in industrial settings.

B. Comparison with Previous Research

To strengthen the validation of findings, the system's performance was compared with results from previous studies related to warehouse information systems. The comparison able highlights differences in accuracy and efficiency outcomes. customers.

Aspek	Penelitian Sebelumnya (Maulana Hasanudin, 2020)	Penelitian Ini (PEM Akamigas)
Sistem yang Digunakan	Manual, berbasis kertas dan spreadsheet	Web-based, PHP, MySQL
Akurasi Pencatatan Data	80%	98%
Waktu Pemrosesan Order	120 menit	60 menit
Metode yang Digunakan	Studi Kasus	R&D, Prototyping
Implementasi	Terbatas, hanya pada beberapa aspek	Sistem penuh, mencakup order, inventaris, dan pelaporan
Analisis Lanjutan	Tidak ada	Ada: Laporan penjualan, peringatan stok rendah

Figure 5 Research Comparrison Table

Based on the comparison, the system developed in this study achieved higher accuracy (98%) and shorter processing times (60 minutes) compared to previous research implementations that still incorporated partial manual processes. These improvements validate that the integration of full web-based features in warehouse operations can optimize both performance and transparency (Sun et al., 2022).

C. System Workflow and Process Visualization

To provide a detailed overview of how the system operates, Figure 6 presents the activity diagram showing the customer order process from login to order completion (Perotti et al., 2022).

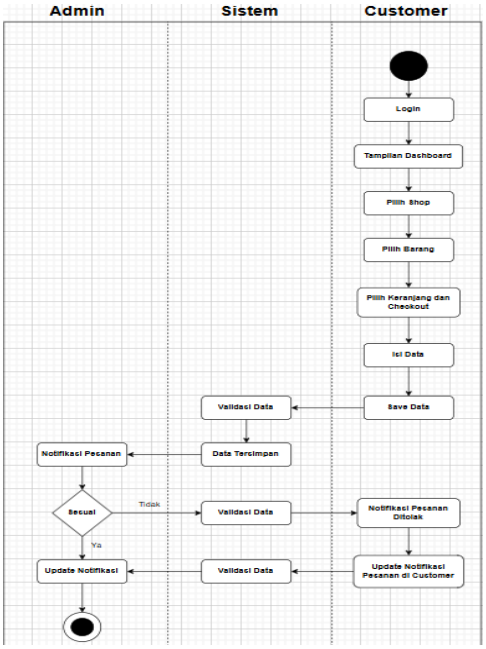

Figure 6 Activity Diagram of Customer Order Process

The activity diagram illustrates that every user interaction—such as logging in, selecting products, and confirming orders—is connected to an automated database process that updates stock levels and generates reports in real-time.

Figure 7 further clarifies this workflow through a flowchart depicting the order processing sequence.

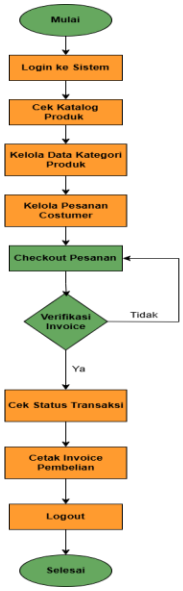

Figure 7 Flowchart of Order Processing

This structured process reduces redundancy and ensures consistency in transaction data. The logical flow guarantees that orders are verified before being finalized, which prevents stock mismatches and reporting errors.

D. System Prototype and User Interface

The developed system features a user-friendly interface designed to support both administrative and customer activities. Figure 8 shows the main dashboard used by administrators.

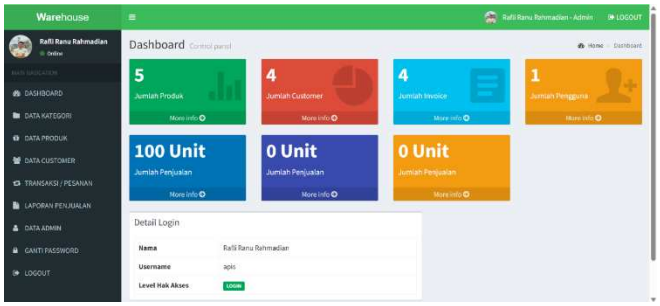

Figure 8 Screenshoot of Admin Dashboard Prototype

The admin dashboard enables real-time monitoring of stock levels, order tracking, and report generation. This feature enhances managerial visibility and ensures operational transparency within the warehouse laboratory.

Figure 9 illustrates the customer ordering page, which allows users to browse product catalogs, submit orders, and receive automatically generated invoices.

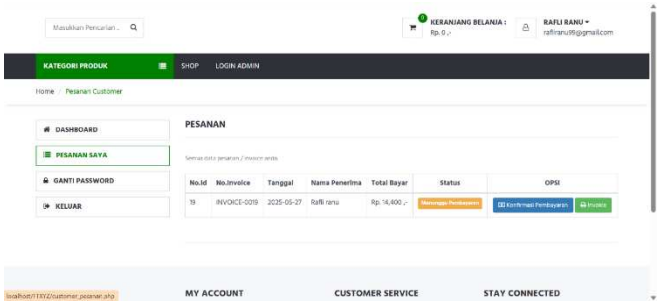

Figure 9 Screenshot of Customer Ordering Page

These visual interfaces simulate actual warehouse management systems used in industry, providing students with hands-on learning experiences aligned with real-world logistics operations.

CONCLUSION

The integration of a web-based material ordering system has successfully transformed the manual processes in the Warehouse Laboratory at PEM Akamigas into an efficient digital framework. The research findings reveal that the system's automation enhances data accuracy by 18% and reduces processing time by 50%. These outcomes align with the study's primary objective of improving both operational efficiency and digital literacy in logistics education.

Additionally, the dual functionality of the system—as both an operational tool and an educational medium—addresses two key needs in the Warehouse Laboratory: (1) improving data management reliability, and (2) preparing students for the challenges of Industry 4.0 environments. By incorporating real-world digital practices into the curriculum, the system fosters a practical understanding of modern logistics technologies. The results of this study are consistent with prior research highlighting the positive impact of integrating digital systems with structured warehouse management. Furthermore, the novelty of this research lies in its application of a professional-grade warehouse management system within an educational setting, successfully bridging the gap between theoretical knowledge and practical industry practices.

This research demonstrates that the adoption of digital tools in educational laboratories is not only vital for enhancing operational efficiency but also crucial in equipping students with the skills needed to thrive in an increasingly digitalized logistics industry. The findings offer valuable insights for other educational institutions looking to modernize their logistics programs and integrate advanced warehouse management systems into their curriculum.

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AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Data curation; System design; Methodology; Writing – original draft; Visualization.

Author 2: Supervision; Validation; Project administration; Writing – review and editing; Resources.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

This research was carried out independently without any external funding or sponsorship. No organization or individual had any influence on the research design, data collection, analysis, interpretation, manuscript preparation, or the decision to publish the findings.

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